MODEL 874

Phase Compensator

Instruction Manual

Part Number 9065 May 1972

esi® Manual

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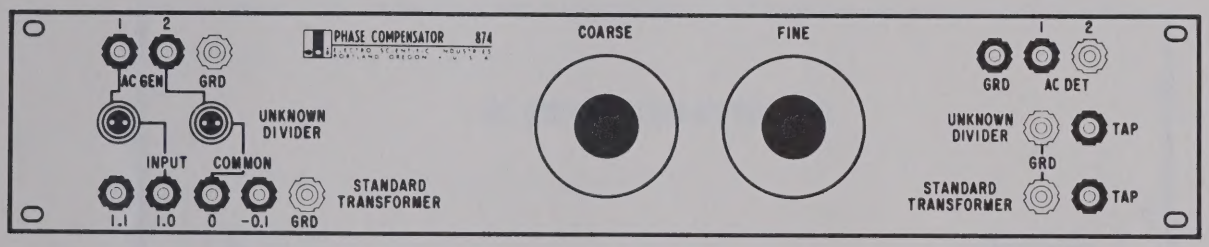

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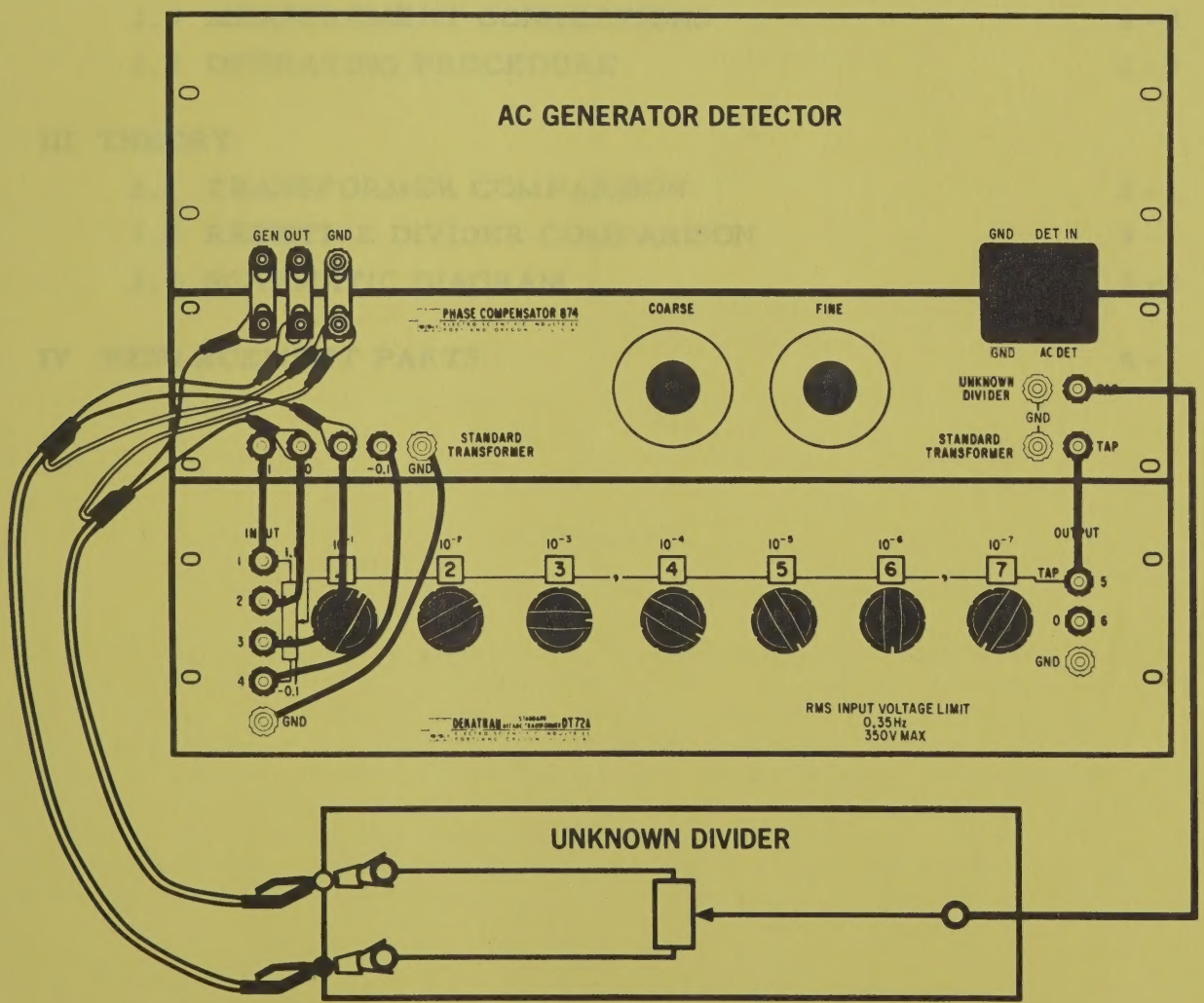
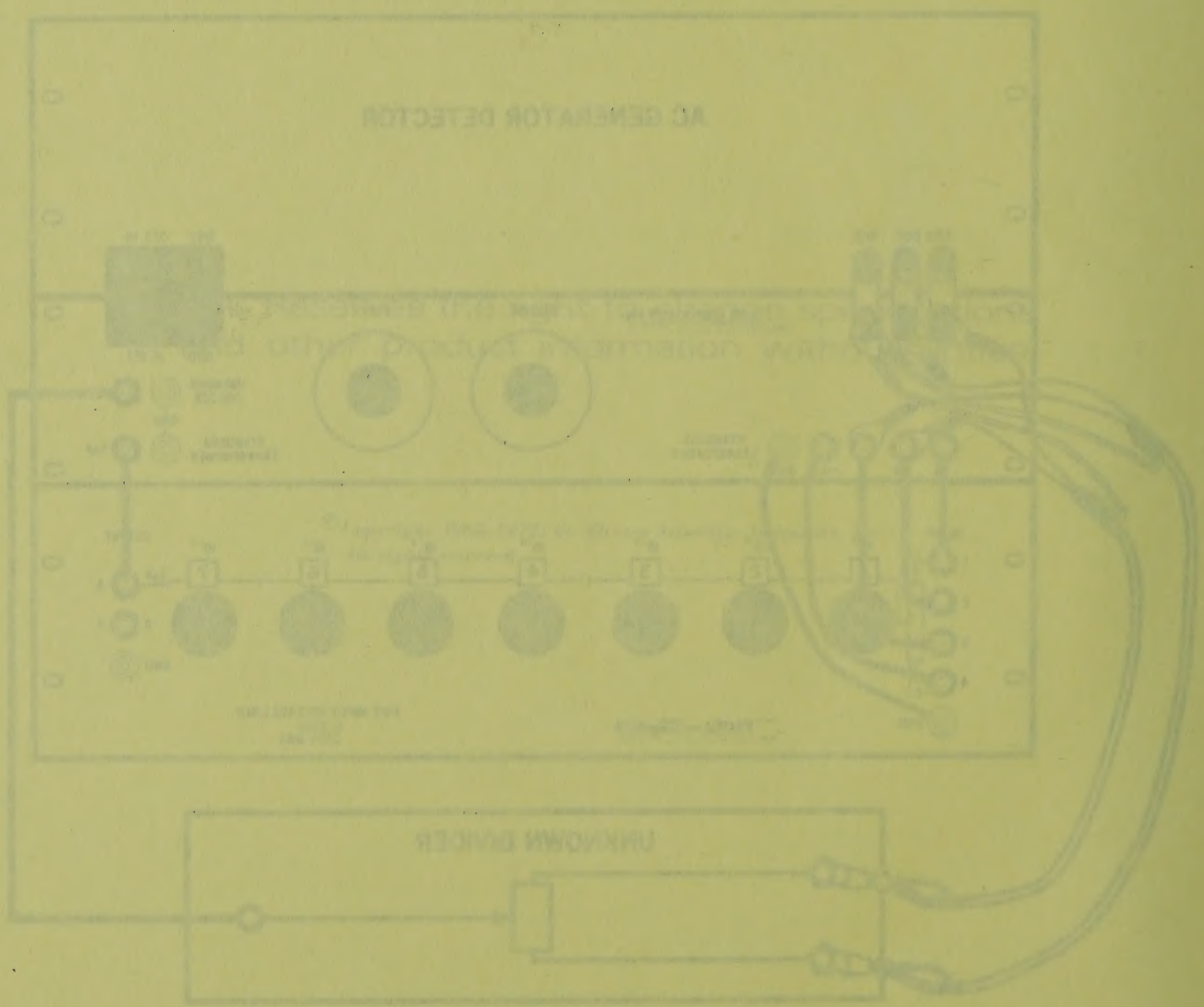
ADDENDUM

Two front-panel connectors labeled, UNKNOWN DIVIDER, have been removed from later versions of the Model 874 Phase Compensator. The KELVIN KLIPS® that were used with the UNKNOWN DIVIDER connector have also been outdated and are now unavailable. The connectors and KELVIN KLIPS were used in a system configuration to make four-terminal connections to an unknown divider.

Four-terminal connections to an unknown divider can still be made (on either early or late Model 874 versions) using the remaining front-panel connectors and different KELVIN KLIPS. The replacement KELVIN KLIPS, P/N 8306, use a spade type connector that connects to the AC GEN 1 and INPUT 1.0 connectors and the AC GEN 2 and COMMON 0 connectors. The Figure below shows how these connections are made. This Figure replaces Figure 2-3 in Model 874 Phase Compensator Instruction Manual.



Making Four-terminal Connections to an Unknown Divider


AC GENERATOR DETECTOR
UNKNOWN DIVIDER

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DEKAVIDER® Decade Voltage Divider
KELVIN KLIPS® Four-terminal Clips
KELVIN KLAMPS® Four-terminal Clamps
PORTAMETRIC® Portable Measuring Instrument
PVB® Potentiometric Voltmeter Bridge

I INTRODUCTION

1.1 DESCRIPTION

The Model 874 Phase Compensator is a device that compensates for the phase difference between the outputs of voltage dividers. With the phase compensation that is possible with this instrument, transformer and resistive dividers can be compared with an accuracy of better than one part per million.

The instrument is basically a special modified differential capacitor which is connected in the measurement circuit as shown in Figure 1-1.

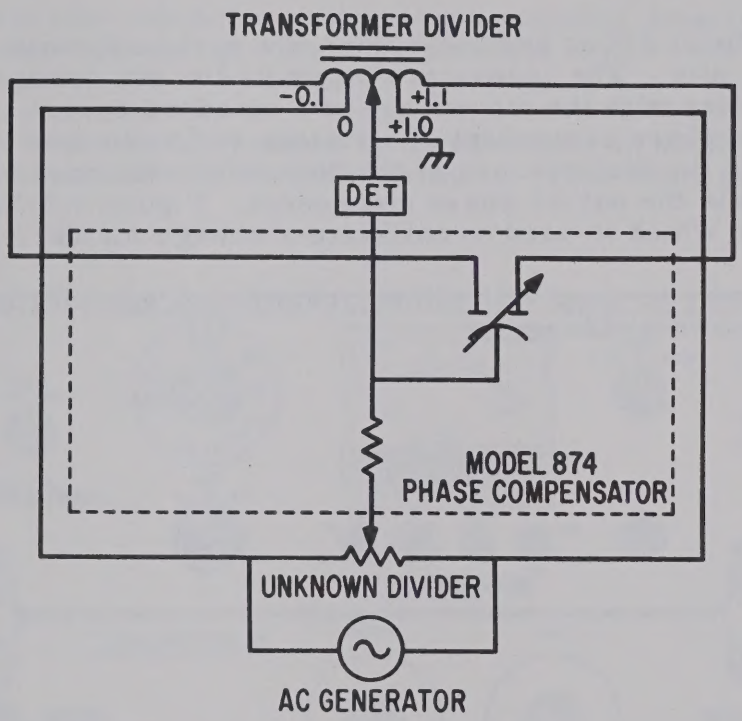

Figure 1-1 Phase Compensated Measurement Circuit

The differential capacitor provides a variable amplitude quadrature voltage; a voltage that is shifted 90° in phase from the input voltage to the dividers. When the differential capacitor is adjusted properly, the difference between the quadrature components of the voltage divider outputs is cancelled out. When the voltage divider ratios are adjusted properly, the in-phase component of the voltage divider outputs are equal. If both the quadrature and in-phase voltages are balanced, a sharp detector null results and very small changes in either the quadrature or in-phase balances can be seen.

1.2 SPECIFICATIONS

The minimum quadrature range with respect to full scale input is approximately as follows for any voltage divider setting (s):

Coarse Dial:	$+(1.1\text{-}S) \times 600 \times f_{kc}$ ppm
	$-(0.1\text{-}S) \times 600 \times f_{kc}$ ppm
Fine Dial:	$+(1.1\text{-}S) \times 15 \times f_{kc}$ ppm
	$-(0.1\text{-}S) \times 15 \times f_{kc}$ ppm

Maximum Input Voltage: 350 volts rms

1.3 APPLICATIONS

Generally the Model 874 is used as a part of a system for making ac ratio measurements. The quadrature output of the instrument is connected in series with the tap voltage of a standard decade transformer. The in-phase component of a voltage ratio can then be determined from the dial settings of the decade transformer since the Model 874 cancels the out-of-phase component. Figure 1-1 illustrates a typical system which is used to calibrate a voltage divider.

The Model 874 may be used with either resistive or transformer voltage dividers as unknown dividers.

II OPERATING INSTRUCTIONS

In most applications, the Model 874 Phase Compensator is combined with a generator-detector and a standard decade transformer to produce a voltage ratio calibration system. The instructions for connecting the measurement system should be carefully followed before making Voltage Divider Calibrations or Impedance Comparisons.

2.1 GENERATOR-DETECTOR CONNECTIONS

A rack-mounted generator-detector such as the ESI Model 861A can be mounted above the Model 874 and connected by links as shown in Figure 2-1. The shield covers over these links (see Figure 2-2) minimize the effects of stray electrical signals.

When using generator-detectors that are not mounted directly above the Model 874, it is important to shield the detector input. The shielding of the generator terminals is optional.

If the detector is internally grounded, there should be no link between the AC DET 1 terminal and the GRD terminal. (The 861A detector is internally grounded.)

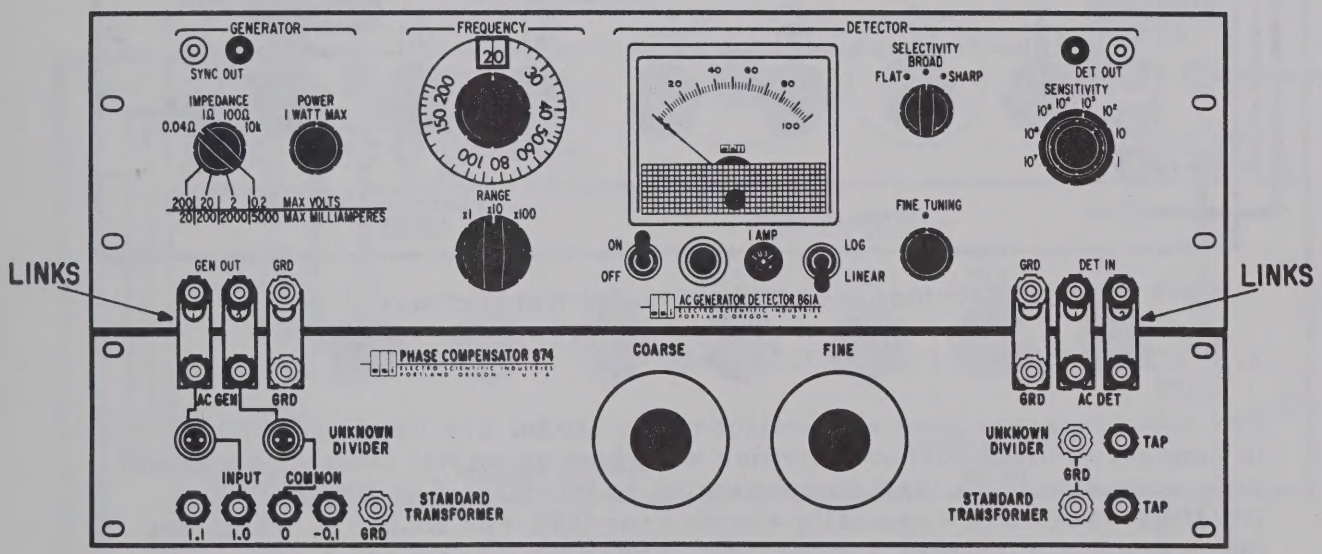

Figure 2-1 Generator-Detector Connections

2.2 STANDARD DECADE TRANSFORMER CONNECTIONS

Normally a standard decade transformer such as the ESI Model DT 72A will be rack-mounted below the Model 874. For most applications the decade transformer is connected as shown in Figure 2-2. It is not necessary to shield the leads to the standard transformer. If the decade transformer is not a DT 72A and does not have 1.1 and -0.1 taps, but has taps labeled HI and LO, INPUT and COMMON, or some similar nomenclature, it may still be used with the Model 874, but phase compensation near the end points of the standard transformer settings may

be insufficient. If such a transformer is used; connect the Model 874 STANDARD TRANSFORMER 1.1 terminal to the 1.0 terminal, connect the 0 terminal to the -0.1 terminal, and connect these terminal pairs to the input terminals of the standard transformer.

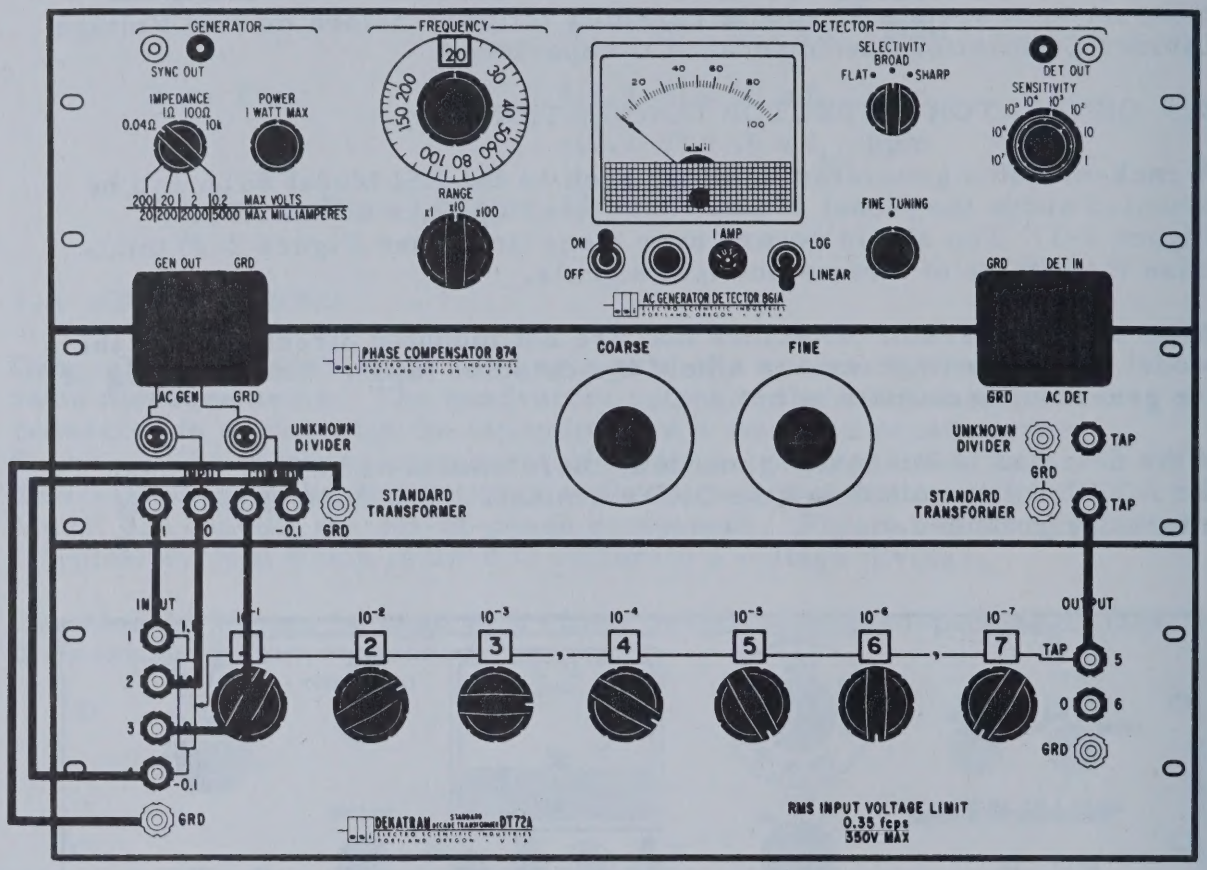

Figure 2-2 Standard Transformer Connections

2.3 MEASUREMENT CONNECTIONS

For most measurement applications, the Model 874 Phase Compensator is connected to an unknown divider with four-terminal connections which reduce or eliminate lead compensation problems. The UNKNOWN DIVIDER jacks are especially adapted for KELVIN KLIPS®, which are four-terminal clip-type connectors. Other four-terminal devices, of course, may be used.

The taps of the standard transformer and of the unknown divider are connected to appropriately labeled terminals on the right-hand side of the instrument.

2.4 OPERATING PROCEDURE

The typical measurement made with a system using the Model 874 Phase Compensator involves two voltage dividers, at least one of which, the standard divider, is a transformer. The following is a description of a typical measurement procedure:

1. Connect generator, detector, and standard transformer to the Model 874 as described in Paragraphs 2.1 and 2.2.

2. Connect unknown divider to Model 874 with Kelvin Klips as shown in Figure 2-3.

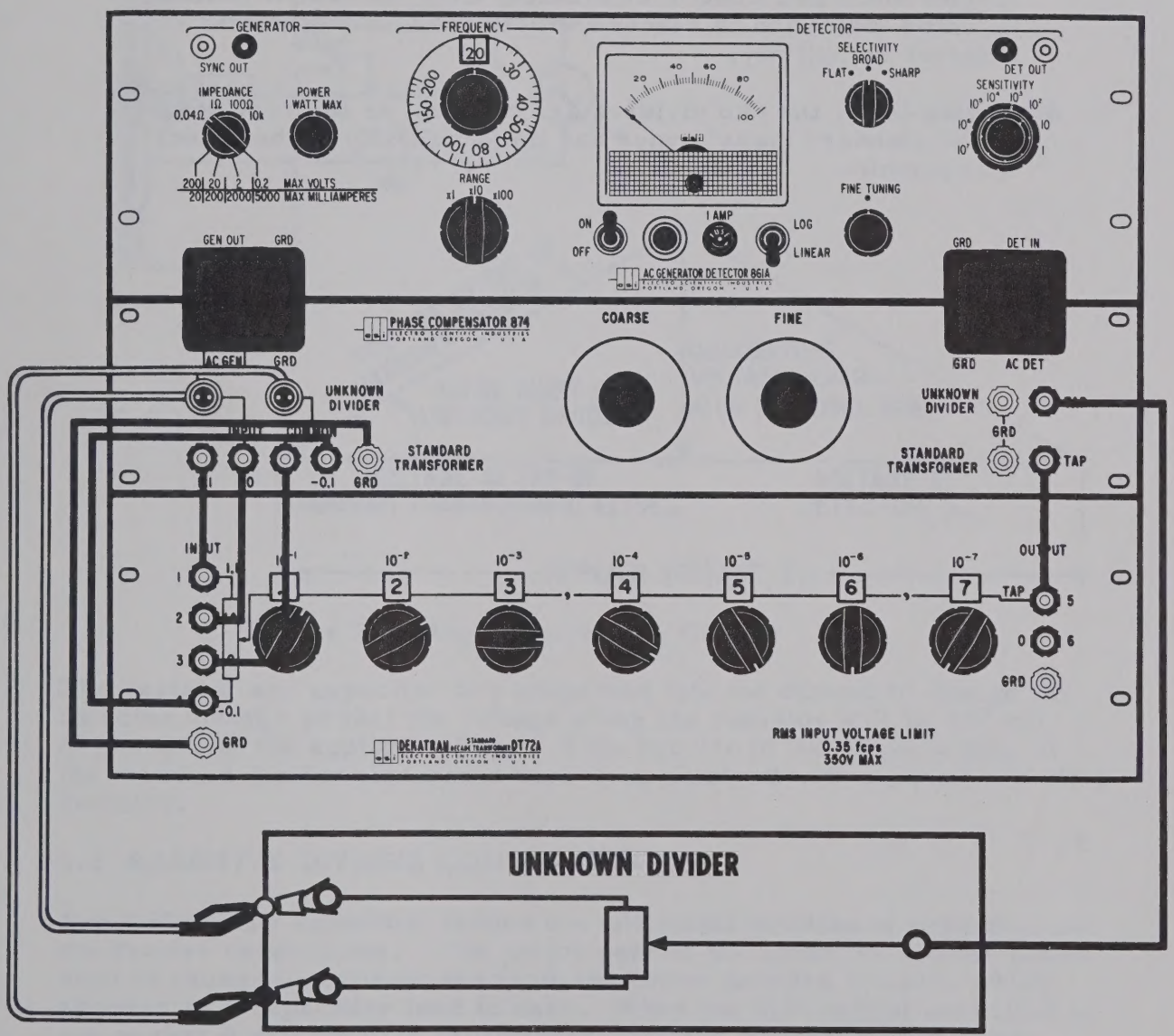

Figure 2-3 Unknown Divider Connections

3. Turn on generator and detector. Allow time for warm-up if necessary.

4. Apply generator power and set detector to a level that is less than full scale.

5. Adjust standard divider for lowest detector indication, increasing detector sensitivity as required. At some point in this step, the detector will be at its minimum indication, and the sensitivity will be still too low for highest accuracy, but if a higher-sensitivity setting is used, the indication will be off scale.

6. Adjust COARSE control for lowest detector indication.

7. Increase detector sensitivity as required, and adjust standard divider and FINE control alternately until the lowest possible detector indication is reached with the greatest possible detector sensitivity.

8. At this time, the two dividers are as equal as the resolution of the standard transformer and the sensitivity of the detector will permit.

III THEORY

The Model 874 Phase Compensator is a capacitor which draws current through a resistance. It can be used to correct for phase differences when comparing dividers.

3.1 TRANSFORMER COMPARISON

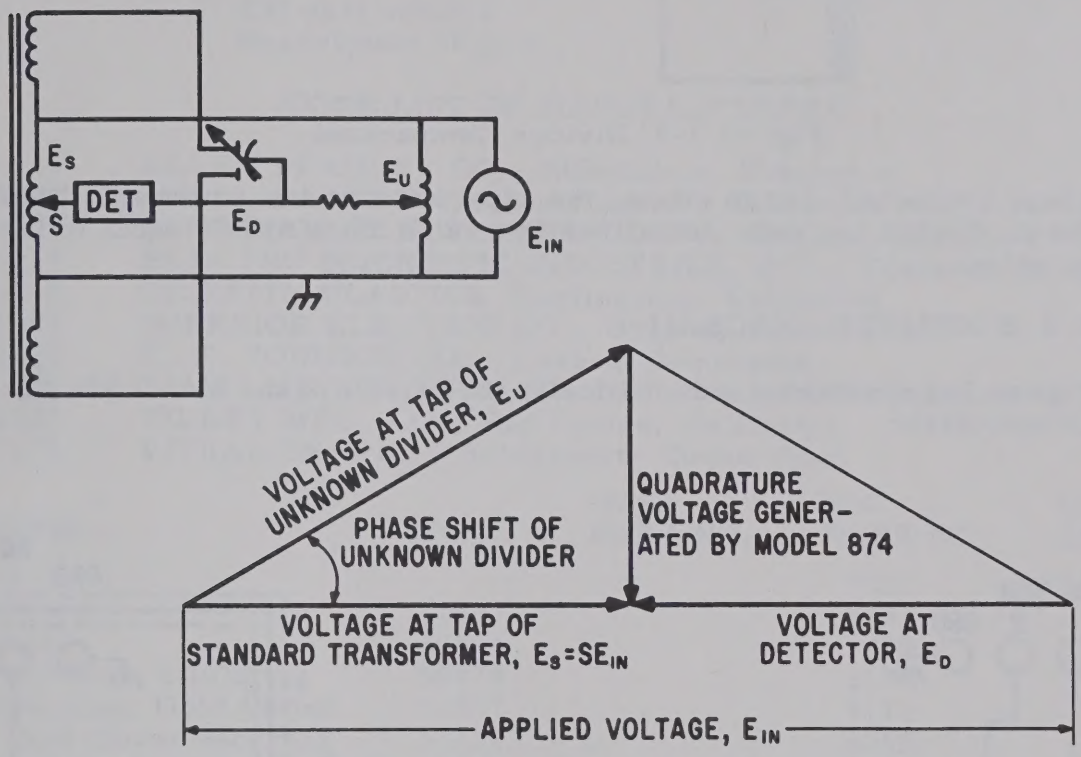

Figure 3-1 Angle Correcting Circuit

The resistor and capacitor are connected into the circuit to change the detector voltage so that the voltage along the resistor will be 90° out of phase with the applied voltage. This results in the same setting of the standard divider that would have been obtained with a phase-sensitive detector.

3.2 RESISTIVE DIVIDER COMPARISON

The differential capacitor serves the additional function of balancing out the divider capacitance. The major part of the resistive divider phase shift is caused by capacitance from the lower decades to case, which appears as a capacitive load to case. When the differential capacitor is set so that it and the load capacitance combine to form a capacitive divider with the same setting as the resistive divider, not only is the

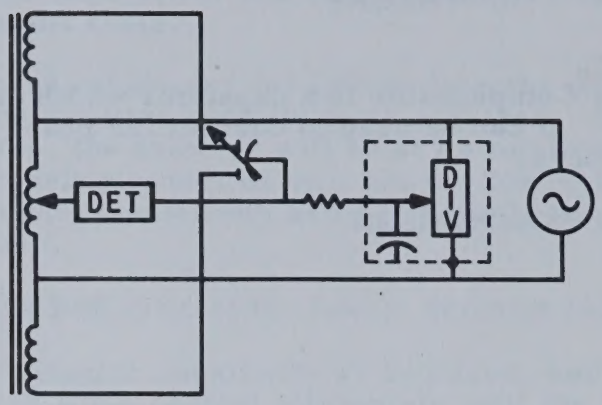

Figure 3-2 Divider Comparison

phase corrected, but in effect, the capacitive load is removed. Thus the ac divider linearity deviations are much more nearly equal to the dc values.

3.3 SCHEMATIC DIAGRAM

Figure 3-3 illustrates schematically the circuit of the Model 874 Phase Compensator.

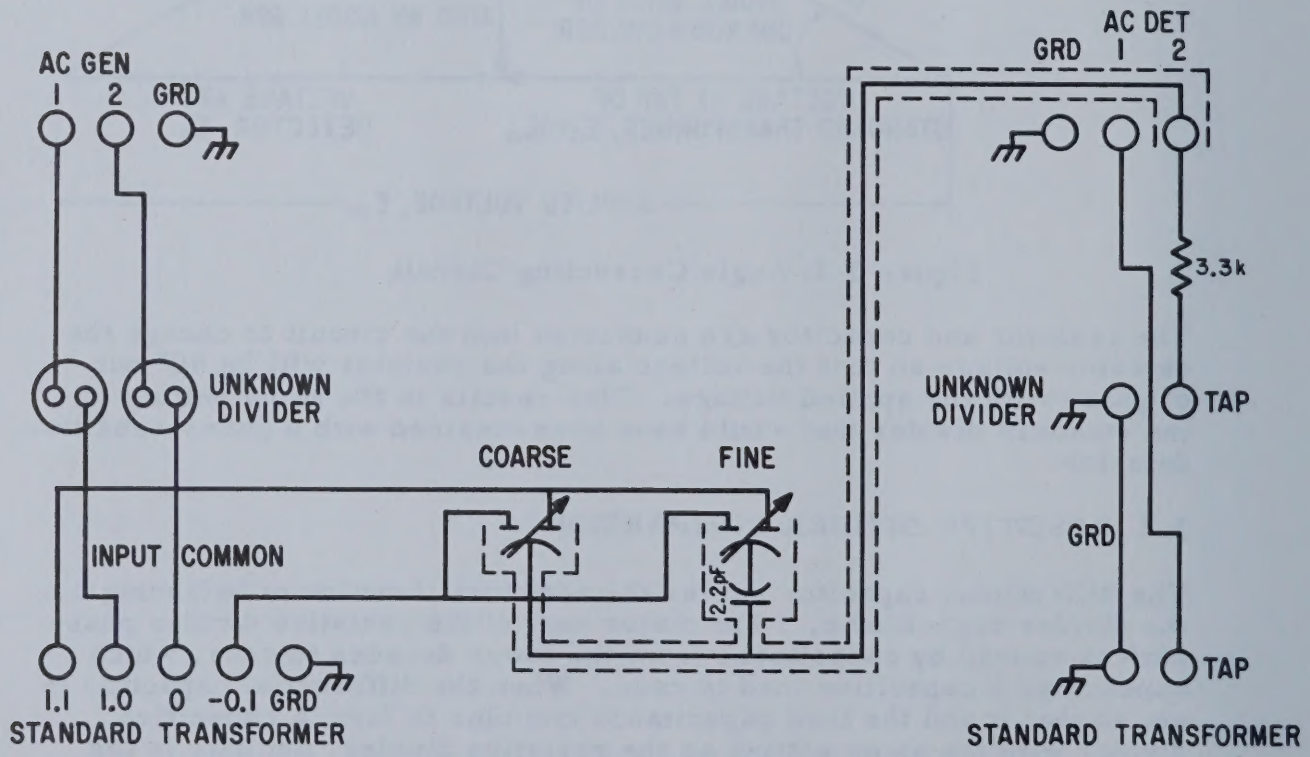

Figure 3-3 Schematic Diagram

IV REPLACEMENT PARTS

The following is an alphabetical parts list. Manufacturer of the part is given in a code number according to the Federal Supply Code for Manufacturers - see list of manufacturers below.

Parts manufactured by Electro Scientific Industries must be ordered from the factory. When ordering parts from the factory, include the following information:

Model and serial number of the instrument
ESI part number
Description of part

CODE LIST OF MANUFACTURERS

01121	ALLEN BRADLEY CO., Milwaukee, Wisconsin
01538	SMALL PARTS INC., Los Angeles, California
02660	AMPHENOL ELECTRONICS CORP., Chicago, Illinois
11837	ELECTRO SCIENTIFIC INDUSTRIES, INC., Portland, Oregon
32767	GRIFFITH PLASTICS, Burlingame, California
58474	SUPERIOR ELECTRIC CO., Bristol, Connecticut
74970	E. F. JOHNSON CO., Waseca, Minnesota
76487	JAMES MILLEN MFG. CO. INC., Malden Massachusetts
78471	TILLEY MFG. CO., San Carlos, California
95275	VITRAMON, INC., Bridgeport, Connecticut

DESCRIPTION	FSCM	MFR PART NO.	ESI PART NO.	QTY USED
Ball Drive			9061	2
Base, Cast	11837		9057	2
Binding Post	58474		1475	15
Binding Post Cap, Insulating	58474		1476	10
Binding Post Cap, Gold Plated	11837		1172	5
Bracket, Dust Cover Securing	11837		9055	2
Bushing, Delrin, Ball Drive Shaft	11837		9053	2
Bushing, Dial	11837		5289	2
Shield, Round	11837		4836	2
Capacitor, Fixed, 2.2 pF	95275	VT13C-2R2C	9063	1
Capacitor, Variable 5-51 pF	74970	167-33	9062	2
Connector, Panel Mount, Female	02660	80PC2F	8378	2
Flexible Coupling, Insulating	76487	39002	8053	2
Dial Assy	11837		9056	2
Dust Cover	11837		7905	1
Grommet, Lead Insulating	01538	G312	1601	6
Insulating Washer, Binding Post	32767		8823	10
Panel, Front	11837		9060	1
Plate, Cap Mounting	11837		9059	2
Resistor, 3.3 kΩ Comp	01121	EB3321	1970	1
Shaft, Coupling	11837		9054	2
Shoulder Washer, Cap Mounting	11837		3058	2
Spacer Disk, Fiber	11837		9064	4
Stop Plate, Ball Drive	11837		9058	2
Test Leads, KELVIN KLIPS®	11837		8309	1 pr
Washer, Nylon, Cap Mounting	78471		73008	2

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During the in-warranty periods, we will service or, at our option, replace, at the factory, any device that fails in normal use to meet its published specifications. Batteries, tubes and relays that have given normal service are excepted.

WARRANTY OF TRACEABILITY

The reference standards of measurement of Electro Scientific Industries, Inc., are compared with the U.S. National Standards through frequent tests by the U.S. National Institute of Standards and Technology. The ESI working standards and testing apparatus used are calibrated against the reference standards in a rigorously maintained program of measurement control.

The manufacture and final calibration of all ESI instruments are controlled by use of the ESI reference and working standards and testing apparatus in accordance with established procedures and documented results. (Reference MIL-C-45662)

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